## REMARKS

Claims 1-4, 7-8, 10-15, 19-20, 22-23, 25-33 are pending. Claims 5-6, 9, 16-18, 21, and 24 were previously canceled. Claims 1, 2, 12, 13, 22, 23, and 33 have been amended to more clearly recite the subject matter of the present disclosure. Particularly, the independent claims (claims 1, 2, 12, 13, 22, 23, and 33) have been amended to recite "expand the precursor graphite perpendicular to a basal plane of the precursor graphite 300 times or more." Support for this amendment exists in the specification with respect to paragraph [0069] which states, "During the process, the flakes expanded as much as 300 times or more, but still many of the layers were attached together and form worm-like shapes." No claims are allowed.

## I. SUMMARY OF OBJECTIONS/REJECTIONS

The examiner sets forth the following objections/rejections:

1. Objection of the amendment filed 5/10/07 under 35 U.S.C. § 132(a) for allegedly introducing new matter into the disclosure for the range "up to five minutes" is maintained from his previous rejection. (See Office Action, ¶ 2.)

2. Claim 1-4, 7-8, 10-15, 19-20, 22-23, and 25-33 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. In particular, the examiner takes issue with the recitation of: (A) "a few seconds to 5 minutes," (See Office Action, ¶ 5A), and (B) "1040 Watts" (See Office Action, ¶ 5B).

3. Claim 1-4, 7-8, 10-15, 19-20, 22-23, and 25-33 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. In particular, the examiner takes issue with the recitation of: (A) "a few seconds to 5 minutes," (See Office Action, ¶ 6A).

5. The examiner maintains his rejection under 35 U.S.C. § 102(b) from the previous office action. Claims 1-4, 7-8, 10-15, 19, and 29-30 are rejected under 35 U.S.C. § 102(b) as being anticipated by Saito et al. U.S. Pat. No. 6,024,900 ("Saito") with Krassowski et al. U.S. Pat. No. 6,395,199 ("Krassowski") and Caines U.S. Pat. No. 4,199,628 ("Caines") being cited as evidence that the temperatures of Saito allegedly give the instantly claimed "worm-like" structure.

6. The examiner maintains his rejection under 35 U.S.C. § 103(a) from the previous office action. Claims 1-4, 7-8, 10-15, 19, and 29-30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Saito with Krassowski and Caines being cited as evidence that the temperatures of Saito allegedly give the instantly claimed "worm-like" structure.

7. The examiner maintains his rejection under 35 U.S.C. § 103(a) from the previous office action. Claims 1-4, 7-8, 10-15, 19-20, 22-23, and 25-33 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Saito in view of Adams et al. U.S. Pat. No. 6,200,915 ("Adams"), Ottinger et al. U.S. Pre-Grant Publication No. 2002/014952 ("Ottinger"), Blain et al. U.S. Pat. No. 6,413,601 ("Blain"), and Cha et al. U.S. Pat. No. 5,164,054 ("Cha"), Greinke et al. U.S. Pat. No. 6,555,271 ("Greinke"), Bonville U.S. Pat. No. 6,248,462 ("Bonville"), and Von Bonin et al. U.S. Pat. No. 5,288,429 ("Von Bonin") with Krassowski and Caines being cited as evidence that the temperatures of Saito allegedly give the instantly claimed "worm-like" structure.

## II. DECLARATION UNDER 37 C.F.R. § 1.132

A declaration of Professor Larry Drzal, an inventor of the present application, is being filed herewith. (See attached Declaration.) According to Professor Drzal, microwave heating results in a distinctively different product

than conventional heating. He also states that one having skill in the art would never be motivated to attempt microwave heating of graphite.

The structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially where the product is defined by the process steps by which the product is made, or where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. See, e.g., *In re Garnero*, 412 F.2d 276, 279, 162 USPQ 221, 223 (CCPA 1979). MPEP 2113.

The product-by-process claims should be considered as to the implied structure achieved by microwave heating. Professor Drzal makes clear that the significant difference in microwave heating as compared to conventional heating.

Affidavits or declarations, when timely presented, containing evidence of criticality or unexpected results, commercial success, long-felt but unsolved needs, failure of others, skepticism of experts, etc., must be considered by the examiner in determining the issue of obviousness of claims for patentability under 35 U.S.C. 103. The Court of Appeals for the Federal Circuit stated in *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538, 218 USPQ 871, 879 (Fed. Cir. 1983) that "evidence rising out of the so-called 'secondary considerations' must always when present be considered en route to a determination of obviousness." Such evidence might give light to circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or unobviousness, such evidence may have relevancy. *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966); *In re Palmer*, 451 F.2d 1100, 172 USPQ 126 (CCPA 1971); *In re Fielder*, 471 F.2d 640, 176 USPQ 300 (CCPA 1973). MPEP 716.01(a).

The evidence submitted herewith (i.e., the Declaration of Professor Drzal) must be considered in evaluating the claims over the prior art. The Declaration makes clear the difference between microwave heating and the prior art conventional heating. It also clarifies that one having skill in the art

would never be motivated to use microwave heating as an alternative since graphite is conductive.

## III. OBJECTIONS ARE OVERCOME

The examiner sets forth his previous objection under 35 U.S.C. § 132(a) for allegedly introducing new matter into the disclosure for the range "up to five minutes". The claims were amended in the previously filed response to office action of September 25, 2008, to recite "a few seconds to 5 minutes." The claims no longer recite "up to five minutes" thereby rendering an objection to this language moot.

The amendment of "a few seconds to 5 minutes" is supported in the specification and overcomes this objection as discussed in more detail below. Applicants request that the objection be withdrawn.

## IV. REJECTION UNDER 35 U.S.C. § 112, FIRST PARAGRAPH

Claim 1-4, 7-8, 10-15, 19-20, 22-23, and 25-33 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. In particular, the examiner takes issue with the recitation of: (A) "a few seconds to 5 minutes," (See Office Action, ¶ 5A), and (B) "1040 Watts" (See Office Action, ¶ 5B).

**(A) Rejection for the limitation "a few seconds to 5 minutes" –**

The first paragraph of 35 U.S.C. 112 provides:

> "The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to **enable any person skilled in the art to which it pertains**, or with which it is most nearly connected, to make and use the same." (Emphasis added.)

According to the MPEP 2161.01:

> "The function of the written description requirement is to ensure that the inventor had possession of, as of the filing

> date of the application relied on, the specific subject matter later claimed by him or her; how the specification accomplishes this is not material. In re Herschler, 591 F.2d 693, 700-01, 200 USPQ 711, 717 (CCPA 1979) and further reiterated in In re Kaslow, 707 F.2d 1366, 707 F.2d 1366, 217 USPQ 1089 (Fed. Cir. 1983)."
> Moreover,
>
> "To satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. See, e.g., Moba, B.V. v. Diamond Automation, Inc., 325 F.3d 1306, 1319, 66 USPQ2d 1429, 1438 (Fed. Cir. 2003); Vas-Cath, Inc. v. Mahurkar, 935 F.2d at 1563, 19 USPQ2d at 1116. ...
>
> Possession may be shown in a variety of ways including description of an actual reduction to practice, or by showing that the invention was "ready for patenting" such as by the disclosure of drawings or structural chemical formulas that show that the invention was complete, or by describing distinguishing identifying characteristics sufficient to show that the applicant was in possession of the claimed invention. See, e.g., *Pfaff v. Wells Elecs., Inc.*, 525 U.S. 55, 68, 119 S.Ct. 304, 312, 48 USPQ2d 1641, 1647 (1998); *Eli Lilly*, 119 F.3d at 1568, 43 USPQ2d at 1406; *Amgen, Inc. v. Chugai Pharmaceutical*, 927 F.2d 1200, 1206, 18 USPQ2d 1016, 1021 (Fed. Cir. 1991) (one must define a compound by "whatever characteristics sufficiently distinguish it"). "Compliance with the written description requirement is essentially a fact-based inquiry that will 'necessarily vary depending on the nature of the invention claimed.'" *Enzo Biochem*, 323 F.3d at 963, 63 USPQ2d at 1613.

The limitation of "a few seconds to 5 minutes" is clearly supported in the specification. In Example 1, ¶ 67 the specification states:

"intercalated graphite flakes were expanded by exposure to microwave energy, typically at 2.45 GHz frequency, for a **few seconds to a few minutes** in an oven. This process can be done continuously by using commercially available microwave systems with conveyors or batch-style process using individual microwave ovens." (Emphasis added.)

The specification in ¶ 62 states:

"Heating for 3 to **5 minutes** removes the expanding chemical." (emphasis added.)

The heating for 3 to 5 minutes is a specific example described in the specification. It is clear from the specification that the claim is supported to enable any person having skill in the art to make and use the invention. The specification provides explicit language of "a few seconds" and "5 minutes." One having skill in the art would be enabled by the specification to microwave the graphite for a few seconds to a few minutes. The language is full, clear, concise, and exact as to enable any person skilled in the art to make or use the same. One skilled in the art would know to use a microwave and also how to microwave for "a few seconds" to "five minutes."

The disclosure of 2.45 GHz is an example, not a formal limitation. The specification explicitly states, "flakes were expanded by exposure to microwave energy, typically 2.45 GHz frequency." The term "typically" indicates an exemplary frequency, obviously not intended to be limiting.

The specification immediately describes several other microwave systems for delivering microwave energy. One skilled in the art would be enabled by reading the claim and understand from the specification that to expose the graphite to microwaves and for a few seconds to five minutes to remove the chemical by boiling. They could take graphite and expose it to microwave energy for the time of a few seconds to five minutes and expect the desired result.

The specification discloses that the time for microwave heating can be from a few seconds to a few minutes and the exposure is not limited to a 2.45 GHz frequency of microwave. Microwave systems are known in the art and sufficient written description exists to show that the inventor has possession of the invention at the time of filing the specification.

The examiner states that the recitation of a few seconds to 5 minutes is "new matter." The specification explicitly discloses these time limits. The examiner cannot assert that an explicit disclosure in the specification constitutes new matter. The applicants make very clear by way of the specification and the examples that microwaving for a few seconds to 5

minutes achieves the desired result. Accordingly, the claims explicitly cover any microwaving of the graphite to expand the graphite for a time period of a few seconds to 5 minutes that will remove by boiling an expander chemical.

The specification clearly shows that the inventors had possession of the claimed subject matter at the date of filing. The specification discloses microwave heating and for a few seconds and in certain circumstances up to 5 minutes. One skilled in the art can reasonably conclude that the inventor had possession of the claimed invention, (i.e., microwave heating for a few seconds to 5 minutes). This was done by the disclosure of procedures and results in the examples as previously stated. The examples showed actual reduction to practice. An embodiment was described that met all the limitations of the claim and determined that the invention would work for its intended purpose. The limitations of the claim include expanding the graphite by heating with microwave energy for a time of a few seconds to a five minutes. These limitations are explicit in the specification.

The embodiments are intended to show reduction to practice and thus are sufficient to support the claim. The limitation recites "to remove by boiling an expander chemical," which provides a boundary for the microwaving and heating. The examiner seems concerned that the specification does not support for any microwave frequency for any amount of time up to 5 minutes and only those specific frequencies disclosed in the exemplary embodiment are supported in the specification. The embodiments show that a time of a few seconds to 5 minutes can expand the graphite using microwave heating. The microwave heating is for this time is sufficient to remove by boiling the expander chemical. The specification supports these recited limitations and the written description requirement has been met.

The examiner states that ¶ 67 is noted and that it relates to "only to a particular microwave frequency whereas the instant claims are not limited as is in section [0067]." The examiner is mistaken in his interpretation. The plain language of the specification discloses an exemplary frequency as evidenced by the language "typically." There is no language in the specification that teaches or suggests that the time limits of a few seconds to a few minutes are

limited to a particular frequency. The frequency of 2.45 GHz is an exemplary microwave frequency that is commonly available in the industry. The language of the specification teaches "typically at 2.45 GHz" but in no way states teaches or suggests *only* at 2.45 GHz as the examiner asserts.

The examiner states the terms, "a few" is not defined in the specification and is therefore unclear as to what is intended by "a few." The language "a few seconds" is clear to one having skill in the art if the skilled artisan knows how to operate microwave systems. A few seconds is a time limitation commonly known and understood to the general population as being greater than zero time. One having skill would not be challenged by this limitation in using the invention as defined by the claims. A few seconds has plain meaning and is easily interpreted by those having skill in the art.

Accordingly, applicants believe that the rejection under 35 U.S.C. §112, first paragraph for failing to comply with the written description requirement has been overcome, at least with respect to the limitation "a few seconds to 5 minutes." Applicants request withdrawal of this rejection.

**(B) Rejection of the limitation "1040 Watts"**

The examiner rejects claim 31 for the recitation "1040 Watts" for failing to comply with the written description requirement. Claim 31 was previously amended in the response to office action mailed September 25, 2008 to recite, "expanded by heating at a power of 1040 Watts for 3 minutes."

It seems the examiner has not considered the new amendment filed in the prior response. Applicants submit that claim 31 was amended to overcome the rejection for failing to comply with the written description requirement. The examiner had suggested the amendment and applicants made such amendment to advance prosecution of this application. Reconsideration is requested.

## V. REJECTION UNDER 35 U.S.C. § 112, SECOND PARAGRAPH

Claim 1-4, 7-8, 10-15, 19-20, 22-23, and 25-33 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicants regard as the invention. In particular, the examiner takes issue with the recitation of: "a few seconds to 5 minutes," (See Office Action, ¶ 6A.) He states that "this nebulous language is not defined in the enabling specification." Applicants respectfully disagree.

> The MPEP § 2164.01 describes the test of enablement as:
>
> "Any analysis of whether a particular claim is supported by the disclosure in an application requires a determination of whether that disclosure, when filed, contained sufficient information regarding the subject matter of the claims as to enable one skilled in the pertinent art to make and use the claimed invention. The standard for determining whether the specification meets the enablement requirement was cast in the Supreme Court decision of Mineral Separation v. Hyde, 242 U.S. 261, 270 (1916) which postured the question: **is the experimentation needed to practice the invention undue or unreasonable?** That standard is still the one to be applied. In re Wands, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988).
>
> Accordingly, even though the statute does not use the term "undue experimentation," it has been interpreted to require that the claimed invention be enabled so that any person skilled in the art can make and use the invention without undue experimentation. In re Wands, 858 F.2d at 737, 8 USPQ2d at 1404 (Fed. Cir. 1988). See also United States v. Telectronics, Inc., 857 F.2d 778, 785, 8 USPQ2d 1217, 1223 (Fed. Cir. 1988) ("The test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation.").
>
> A patent need not teach, and preferably omits, what is well known in the art. In re Buchner, 929 F.2d 660, 661, 18 USPQ2d 1331, 1332 (Fed. Cir. 1991); Hybritech, Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1384, 231 USPQ 81, 94 (Fed. Cir. 1986), cert. denied, 480 U.S. 947 (1987); and Lindemann Maschinenfabrik GMBH v. American

Hoist & Derrick Co., 730 F.2d 1452, 1463, 221 USPQ 481, 489 (Fed. Cir. 1984).

The specification, when filed, contained sufficient information regarding the time for microwaving the graphite to remove the chemical as to enable one skilled in the art to make and use the invention. The time of a few seconds to 5 minutes is a limited time range. The experimentation needed to practice the invention is neither undue nor unreasonable. One having skill in the art clearly understands what it means to microwave for "a few seconds." Even if one skilled in the art needed experimentation, it would not be undue or unreasonable.

Accordingly, the specification satisfies the test for enablement. Applicants have traversed the rejection for lack of enablement and request reconsideration of this rejection.

## VI. REJECTION UNDER 35 U.S.C. § 102(b)

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631 (Fed. Cir. 1987). As set forth in detail below, applicants respectfully submit that the applied references fail to disclose all recited limitations of the applicants' claims.

Accordingly, the claims are not anticipated and the applicants request withdrawal of the anticipation rejections of all claims 1-4, 7-8, 10-15, 19, and 29-30.

### A. Summary of the Rejections under 102(b)

The examiner rejects claims 1-4, 7-8, 10-15, 19, and 29-30 under 35 U.S.C. § 102(b) as being anticipated by Saito with Krassowski and Caines being cited as evidence that the temperatures of Saito give the instantly claimed "worm-like" structure. Particularly, the examiner states, "It is not seen that the heating means of the instant claims gives a different result than that

of the patentee via probative evidence that is commensurate in scope with the instant claims and the cited prior art." (See e.g., outstanding action, ¶ 9.)

**B. Interview Summary from Continuation Application 11/361,255**

Application 11/361,255 is a continuation application of the present application. A telephonic interview with examiner Patrick D. Niland took place on February 12, 2009, at the request of applicants' representative, Mikhail Murshak (Reg. No. 58,472) related to the '255 application. Similar rejections related to the time for microwave heating were set forth in the '255 application.

In the interview, applicants' representative suggested the possibility of pursuing only method claims 12–15, 17-20, and 31-33 of the '255 application to expedite prosecution. The examiner reasserted his position that microwaving intercalated graphite is an obvious variation of conventional heating.

Applicants' representative argued that the Declaration under C.F.R. § 1.132 was filed showing that microwaving showed better removal of an intercalated chemical in a precursor graphite than conventional heating. The examiner acknowledged that the Declaration supported better results for microwaving over the prior art conventional heating, but that this result was limited to the specific examples provided in the declaration. The examiner also acknowledged that the main reference Saito et al. (U.S. 6,024,900) does not teach or suggest microwave heating to expand graphite. The examiner held his position that the evidence was not commensurate with the scope of the claims in that the claims are not limited to a specific wattage, time range, temperature, and possibly other limitations reflecting the degree of treatment of the precursor graphite.

The examiner suggested that the applicants possibly amend the claims to include a limitation directed to the improved result, i.e., degree of cleanliness or expansion that is achievable by microwave and not by conventional heating.

Alternatively, the examiner stated that the claims may be allowable if evidence was provided that showed the one having skill in the art would not attempt or use microwave in expanding graphite.

No agreement was reached during the interview.

**C. Summary of the Amendments**

The amendments to independent claims 1, 2, 12, 13, 22, 23, and 33 submitted herein recite an improved result of "expanding the graphite 300 times or more..." This expansion is a result of microwaving and provides an unexpected result over conventional heating. None of the references teach or suggest a material with graphite expanded to 300 times or more. Moreover, expansion of graphite intercalated compounds were investigated by the applicants to compare conventional heating versus microwave heating as evidenced by the Declaration under 37 C.F.R. § 1.132 by the inventor, professor Lawrence T. Drzal, which was filed on June 22, 2006.

Professor Drzal states in his Declaration that, "graphite expanded by a microwave process has a higher degree of expansion and has a cleaner surface than graphite expanded by a heat treatment." (See Declaration, page 3.) It is also shown in the dissertation as Exhibit A of the Declaration that:

There are several methods to expand GICs. The most commonly used technique is the rapid heating in a furnace. This is widely used in the commercial stage. Other methods can include infrared, laser, microwave, and electric current. Among these, microwave systems are available in many sizes and power levels, yet very little has been investigated about microwave exfoliation of GICs. In this research, natural crystalline graphite-based acid intercalated graphite compounds were exfoliated by heating or a microwave processes. The effects of temperature, microwave power, and the size of graphite flakes on degree of expansion were examined by XRD. Also the surface chemistry of the exfoliated graphite samples was investigated by XPS. It revealed that the microwave process could give a better degree of expansion and a cleaner surface at lower cost. These expanded graphite samples were pulverized and milled into sub-micron graphite flakes. SEM and TEM images showed that the average size of graphite became 0.86um and the thickness of around 10 nm. The cost of this new nano-size graphite material was estimated to be around $5/lb. With its superior mechanical, electrical, thermal properties and cost effectiveness, this material could be used in variety of applications such as nanocomposites, secondary batteries, and fuel cells.

(See Exhibit A, Declaration, page 71.)

One skilled in the art would not recognize that a cleaner surface could be produced in such a short time with that degree of expansion as a result of microwave heating. The flakes expanded as much as 300 times or more during the process while forming worm-like shapes. Accordingly, not only does microwave heating provide a shorter necessary time to achieve expansion, the actual expansion is significantly better than traditional heating. Moreover, the surface is cleaner. There is no teaching or suggestion in any of the applied references that would indicate these results would be achievable through conventional heating. Thus, it is the particular aspect of microwave that provides these unexpected and surprising results.

Applicants submit that the claims are distinguished over the applied references and request a notice of allowance.

**D. Summary of the Applied Reference**

As summarized in the previous response to office action, **Saito** teaches that production of expanded graphite from the raw material can be conducted by a known process. "For example, concentrated sulfuric acid is mixed with hydrogen peroxide to form peroxomonosulfuric acid; thereto is added raw material graphite with stirring to give rise to a reaction for about **1 hour to 1 day**; and the reacted graphite is heated at 500-1000°C in an inert gas". (Saito, col. 2, lines 59-65, emphasis added). According to Saito, "The present invention may be expanded graphite obtained by adding 15% ammonium hydrogenperoxodisulfate to a mixture of 320 parts by weight of 95 wt. % concentrated sulfuric acid and 4 parts by weight of 62% hydrogen peroxide, mixing them with cooling to 20°C or lower, adding natural graphite to the mixture to give rise to a reaction for **24 hours**, and firing the reaction product up to 1000°C in nitrogen gas" (col. 2, line 67 to col. 3, line 12, emphasis added). Moreover, Saito discloses, "Further, it is necessary that at least 80% of the total particles of the graphite powder used in the present invention have particle diameters of 0.1-20 μm." (Saito, col. 3, lines 34-36.)

Saito describes using a conventional heating process to expand the graphite. Saito does not disclose or suggest that a microwave process for a very limited period of time should be used to produce expanded graphite having superior properties as compared to graphite expanded by a high temperature heat treatment.

Saito does not disclose or suggest expanding the graphite 300 times or more.

In order to anticipate, Saito must disclose or suggest each element of the claims. Saito does not disclose the following elements: (i) microwaving, (ii) heating for a few seconds to 5 minutes; or (iii) expanding the graphite 300 times or more. Each of these elements is explicitly recited in the applicants' claims. Since Saito fails to disclose or teach any of these elements individually or as a whole, Saito fails to anticipate the independent claims.

Applicants further reassert the arguments that the structure implied by the process in a product-by-process claim must be considered.

**E. The structure implied by a product-by-process claim is considered when assessing patentability over the prior art**

The structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially where the product is defined by the process steps by which the product is made, or where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. See, e.g., *In re Gamero*, 412 F.2d 276, 279, 162 USPQ 221, 223 (CCPA 1979). MPEP 2113.

Affidavits or declarations, when timely presented, containing evidence of criticality or unexpected results, commercial success, long-felt but unsolved needs, failure of others, skepticism of experts, etc., must be considered by the examiner in determining the issue of obviousness of claims for patentability under 35 U.S.C. 103. The Court of Appeals for the Federal Circuit stated in *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538, 218 USPQ 871, 879 (Fed. Cir. 1983) that "evidence rising out of the so-called 'secondary considerations' must always when present be considered en route to a determination of obviousness." Such evidence might give light to circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or unobviousness, such evidence may have relevancy. *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966); *In re Palmer*, 451 F.2d 1100, 172 USPQ 126 (CCPA 1971); *In re Fielder*, 471 F.2d 640, 176 USPQ 300 (CCPA 1973). MPEP 716.01(a).

**F. Saito fails to disclose each element of applicants' claims**

Independent claims 1, 2, 12, 13, 22, 23, and 33 of the present application include a product-by-process limitation reciting "expanded by heating in a microwave or radiofrequency applicator for a time of a few seconds to 5 minutes to remove by boiling."

The independent claims further recite "expand the precursor graphite perpendicular to a basal plane of the precursor graphite 300 times or more."

The structure implied by the microwave or radiofrequency wave treatment step should be considered. The microwave or radiofrequency wave treatment provides beneficial and structurally different results according to the relevant evidence provided in the prior office action responses.

In particular, the Declaration under 37 C.F.R. § 1.132 by the inventor, professor Lawrence T. Drzal, filed on June 22, 2006 states, "graphite expanded by a microwave process has a higher degree of expansion and has a cleaner surface than graphite expanded by a heat treatment." (See Declaration, page 3.) Included in the Declaration is chapter 2 of the dissertation of Hiroyuki Fukushima (also an inventor of the present application), entitled "Exfoliated Process for Graphite Intercalation Compounds, attached as Exhibit A. This chapter explains that graphite expanded by a microwave process has superior properties as compared to graphite expanded by a heat treatment. The dissertation explains in pertinent part:

> - "The surface areas of microwave exfoliated graphite samples were more than 4 times larger than those of the heat exfoliated samples." - Fukushima, page 84, 2nd paragraph. , (Also see, Figure 2.11 and Table 2.1.)
>
> - "It revealed that the microwave process could give a better degree of expansion and a cleaner surface at lower cost." – Fukushima, page 71, 2nd paragraph.
>
> - "By comparing the heating process, Figure 2.4, and the microwave process, Figure 2.6, it was shown that microwave process could give the same or better degree of expansion for graphite flakes." - Fukushima, page 82, 3rd paragraph.
>
> - "It revealed that overall microwave treatment showed a better degree of expansion than conventional heating process, including heating at the temperature of 600°C to 800°C, which is commonly used in the commercial expansion processes." - Fukushima, page 84, 1st paragraph. (See also, Figures 2.7, 2.8, 2.9, and 2.10.)

> - "The physical principle of dielectric heating, which includes microwave and radio frequency heating, is based on the transformation of electromagnetic field energy into thermal energy in polar materials. Dipoles of polar materials change their direction by following the direction of the electromagnetic field, causing friction between molecules and transform the applied microwave energy into thermal energy. Microwave process has many advantages over conventional heating such as less energy consumption, faster process, *homogeneous and simultaneous heating throughout the whole sample*, and higher process capacity. Because of these advantages, the microwave process also offers a considerable cost reduction. Fukushima, page 82, 1st paragraph.

The fuming inorganic oxy acid has higher dielectric constant than graphite. This enables the radiofrequency waves or microwaves to heat the acid inside the precursor graphite more efficiently, causing **explosive** expansion of the graphite. Conventional heating methods only heat the graphite gradually from outside, offering relatively slow heating which causes relatively slow and less effective expansion.

Since the process of microwaving causes a completely different physical effect on the graphite than conventional heating, the two processes (microwave and heating) can not be considered as equivalent to each other. Also, conventional heating cannot cause the graphite to expand 300 times or more.

The examiner sates, "It would appear that these different energy forms would lead to the same products, particularly given the lack of specificity of the instant claims in establishing any *unobviously* different structure between the two graphites." (See e.g., outstanding action, ¶ 9; emphasis added.) The examiner has not provided sufficient weight to the comparison provided in the Fukushima dissertation from section 2.3.3, pages 84 – 94. As shown hereinabove by the pertinent portions of the Fukushima dissertation, microwave expanded graphite is significantly different than heat treated graphite.

A consideration of "unobviously different structure" is improper for an anticipation rejection since the prior art reference must disclose each and every element of the applicants' claims.

Saito fails to disclose the process of heating the graphite with radiofrequency waves or microwaves for a time of a few seconds to 5 minutes. Saito also fails to disclose expanded graphite that is pulverized to produce the platelets, which consist essentially of a distribution of single platelets. Saito also fails to disclose to expand the graphite 300 times or more.

Claims 2 and 13 each recite platelets that have a thickness of about 30 nm. Saito fails to disclose graphite platelets of this thickness. In fact, Saito teaches away from this recitation since it states, "Further, it is necessary that at least 80% of the total particles of the graphite powder used in the present invention have particle diameters of 0.1-20 um." (See e.g., Saito, col. 3, lines 34-36.)

Accordingly, Saito fails to disclose each element of applicants' independent claims and thus, the anticipation rejection is overcome. Applicants request that the anticipation rejection be withdrawn.

## VII. CLAIM REJECTIONS UNDER 35 U.S.C. § 103(a)

A *prima facie* case of obviousness requires that each and every limitation of the claim is described or suggested by the prior art, or would have been obvious based on the knowledge of those of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988). Accordingly, the failure of the applied references to teach or suggest all recited claim limitations precludes a conclusion of prima facie obviousness. *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988); MPEP § 2143.

The implied structure of the process step of microwave or radiofrequency wave treatment is different then that of Saito alone or in combination with any of the applied references as evidenced by the Declaration filed June 22, 2006. Saito alone or in combination with the

applied references fails to disclose, teach, or suggest all recited elements of the claims since neither reference describes the process step of microwave or radiofrequency treatment.

The claims are amended to recite, "graphite expanded 300 times ore more." None of the references teach or suggest this limitation.

The evidence provided, (i.e., the Declaration and appended dissertation) shows that microwave treated graphite is unique over conventional heating. In view of the asserted prior art references, this difference is equivocal to unexpected results since neither Saito alone or in combination with any of the applied references disclose, teach, or suggest microwave treated graphite.

Thus, the applicants submit that the present obviousness rejections are traversed. Accordingly, the Office Action fails to present a *prima facie* case of obviousness for all pending claims.

**A. Summary of the Rejections under 35 U.S.C. § 103(a)**

The examiner maintains his rejections from his prior office action rejecting the claims as described in ¶ 6 and ¶7 of section (I) above.

**B. Summary of the Applied References**

**Adams** describes a textile fabric coated with an elastomer silicone composition with laminar form. Expanded graphite is mentioned in a range from 5 to 500 μm (microns; 5 to 500 x 10-6 M). These are conventional expanded graphite particles which are much different from those of the present invention which have been expanded with microwaves or radiofrequencies for a few seconds to 5 minutes as now claimed.

**Ottinger** describes conventional expanded graphite in its expanded form as described at paragraph [0036]. The graphite is not expanded using microwaves or radiofrequency heating for a few seconds to 5 minutes as in independent Claims 1, 12, 13, 21, 22 and 29.

**Blain** describes a thermal insulating device composed of layers of graphite separated by layers of polymer. Blain teaches that graphite flakes

can be exfoliated by exposing them to an energy source, including microwave or radiofrequency radiation. However, Blain does not discriminate between microwave radiation and other sources of energy, such as heat sources including a flame or energy provided by infrared radiation in relation to the direction of heating. The present independent claims recite "for a time of a few seconds to 5 minutes so as to remove by boiling the chemical comprising a fuming organic oxy acid from the precursor graphite." Blain does not disclose the time period for microwave heating or the precursor graphite comprising the fuming organic oxy acid. As can be seen from the Declaration, the microwave treatment provides structural benefits as described above.

**Cha** describes a process for producing hydrogen and carbon black. There is no discussion of expanding graphite. This reference is remote from the present invention and one skilled in the art could not possibly derive expanding of graphite using microwaves or radiofrequency waves for a few seconds to 5 minutes from this reference. The production of hydrogen from graphite is not even remotely related to the claimed invention.

**Greinke** relates to a lithium ion battery. This reference teaches that graphite is laminated to a metal substrate. An anode is created from exfoliated graphite. The examples refer to "worms" of exfoliated graphite. This reference is remote from the present invention since there is no suggestion of the graphite expanded for a few seconds to 5 minutes with microwave or radiofrequency heating.

**Bonville** describes a "porous graphite" anode alone or in combination with a polymer and catalyst for use in an electrochemical free cell assembly. There is no suggestion of the presently claimed invention comprising microwave or radiofrequency wave expanded for a few seconds to 5 minutes from this reference.

**Von Bonin** describes a process for expanding graphite in a mold using a liquid in graphite. Von Bonin teaches that microwaves are one method of heating the expandable graphite, but does not teach advantages of a microwave treatment over conventional heating. There is no suggestion of

heating for a few seconds to 5 minutes with microwaves or radiofrequency waves.

**B. The applied references alone or in combination fail to disclose, teach or suggest each element of the applicants' claims**

The examiner indicated in his interview that a structural improved result captured in the claims so long as it was supported by the specification would likely be allowable. The claims are amended to recite in pertinent part, "expand.....300 times ore more." None of the applied references teach or suggest this result or structural improvement. Accordingly, since the references alone or in combination fail to teach or suggest every element of the claims, they fail to render the claims obvious.

Moreover, as previously submitted in the last response to office action, according to MPEP § 2113, the structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially where the product can only be defined by the process steps by which the product is made, or where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. *In re Garnero*, 412 F.2d 276, 279, 162 USPQ 221, 223 (CCPA 1979) (holding "interbonded by interfusion" to limit structure of the claimed composite and noting that terms such as "welded," "intermixed," "ground in place," "press fitted," and "etched" are capable of construction as structural limitations).

The graphite in the claims of the present application has been described by a product-by-process limitation. The precursor graphite has been expanded by heating in a microwave or radiofrequency wave applicator. Therefore, the structure implied by the process steps should be considered when assessing the patentability of the claims over the prior art.

Adding energy via microwave or radiofrequency by heating over a period of a few seconds to 5 minutes produces different platelets than those of the prior art. The Declaration Under 37 CFR 1.132 illustrates that graphite expanded by the claimed microwave or radiofrequency process for a few

seconds to 5 minutes has superior properties as compared to graphite expanded by a heat treatment.

The graphite expanded by a microwave process has a higher degree of expansion and has a cleaner surface than graphite expanded by a heat treatment. As can be seen in Table 2.1 and in Figure 2.11 on page 88 of the dissertation of Hiroyuki Fukushima, entitled "Exfoliated Process for Graphite Intercalation Compounds", microwave exfoliated graphite has approximately a ten fold higher surface area and aspect ratio than heat exfoliated graphite. In addition, since intercalated acid residue remaining on the graphite surfaces after treatment could cause problems, the cleanness of the graphite surface is important. Section 2.3.3.2 on page 89 of the dissertation of Hiroyuki Fukushima shows that the microwave treatments have an advantage over the conventional heating process in terms of removal of the residual intercalates. Thus, graphite expanded by a microwave process has superior properties as compared to graphite expanded by conventional heating processes.

**C. The examiner has not properly considered the evidence**

The examiner has not given proper consideration to the evidence previously submitted by the applicants related to microwave heating. Moreover, the examiner has not rebutted the evidence provided in the Declaration and associated dissertation. The examiner has not provided evidence or pointed to a reference which would indicate that microwave heating does not provide unique and unexpected results as shown by the applicants.

These results are unexpected considering the teachings of the cited references. Particularly, it is unexpected to expand a graphite 300 times or more by using a microwave over conventional heating. None of the cited references alone or in combination teach the advantages of graphite expanded by the claimed microwave or radiofrequency wave process for a few seconds to 5 minutes. Saito, Adams, Ottinger, Blain, Cha, Greinke, Bonville, and Von Bonin, either taken alone or in combination, do not disclose, teach or suggest the applicants' independent claims.

The rejection for obviousness has been overcome. Applicants request that the obviousness rejections be withdrawn.

## VIII. AMENDMENT TO RECITE "A FEW SECONDS TO FIVE MINUTES"

The claims have been amended to recite generally heating by microwave or radiofrequency waves for a time of a few seconds to 5 minutes to remove by boiling the chemical. In previous Office Actions, the examiner has rejected the limitation of "up to 5 minutes". The claims are supported in the specification as discussed above.

The Patent and Trademark Office ("PTO") determines the scope of claims in patent applications not solely on the basis of the claim language, but upon giving claims their broadest reasonable construction "in light of the specification as it would be interpreted by one of ordinary skill in the art." *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364[, 70 USPQ2d 1827] (Fed. Cir. 2004). The language of the claims must be read in the context of the claim language. The claim recites a conjunctive limitation, "a precursor graphite has been expanded by heating in a microwave or radiofrequency applicator for a time of a few seconds to five minutes" and "to remove by boiling an expander chemical." Thus, the limitation requires both that "boiling" and for a time period of "a few seconds to five minutes" be performed in the process step.

Clearly, boiling an intercalcant for time period of zero is not possible since by definition, at zero time, no boiling can be achieved. A precise lower limit is a few seconds and will depend on specific environmental and/or laboratory conditions and parameters. These parameters can be determined by the skilled artisan when practicing the claimed invention. Determining these parameters would not cause an undue burden or experimentation on the skilled artisan.

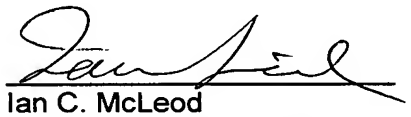
Support for the time range of a few seconds to 5 minutes exists in the original specification as previously discussed. The specification provides support for the upper limit of 5 minutes with respect to paragraph [0062].

Support for less than 3 minutes exists with respect to paragraph [0067] in Example 1. (i.e., "a few seconds to a few minutes".) Accordingly, the time period of "a few seconds to 5 minutes" is fully supported by the written description of the application as filed.

## IX. CONCLUSION

The applicants submit that Claims 1-4, 7-8, 10-15, 19-20, 22-23, 25-33 are in condition for allowance. The remarks provided herein overcome the objections and rejections set forth by the examiner. The applied references alone or in combination fail to anticipate and/or render obvious the claims. Accordingly, the applicants respectfully request that a Notice of Allowance be issued and the objections and rejections be withdrawn.

Respectfully,



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Enclosure: Declaration Under 37 CFR 1.132